677,142 PROVISIONAL SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale.*

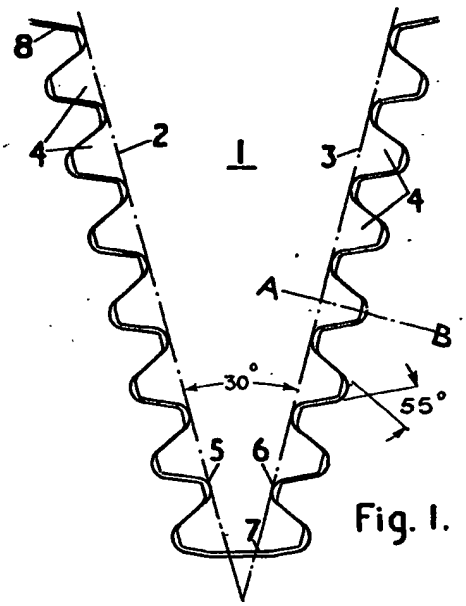

Fig. 1.

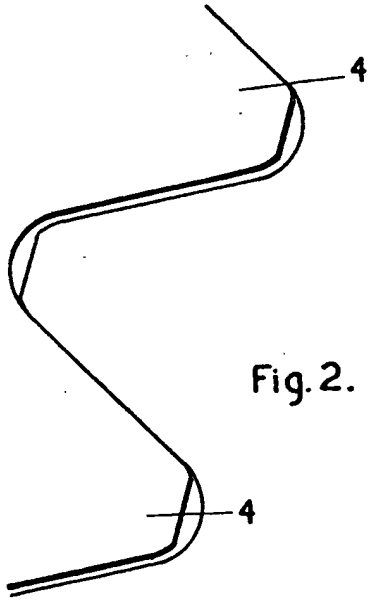

Fig. 2.

1020 - M.M.P.LTD - 1952

PATENT SPECIFICATION

Inventor: PETER MARTIN

677,142

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COMPLETE SPECIFICATION

Improved Mounting for Turbine and like Blades

We, POWER JETS (RESEARCH AND DEVELOPMENT) LIMITED, a British Company, of 25, Green Street, London, W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an improved mounting for rotor blades for axial flow turbines, compressors and the like of the kind which are attached to the rotor disc by the provision on the blade of a radially extending root section adapted to enter a radially and axially extending seating recess in the rotor rim, both root and recess tapering inwardly in width to present an approximately triangular form, and the inclined sides of the root section having toothed serrations adapted to engage in complementary serrated grooves in the inclined sides of the rotor recess, so that radial displacement of the blade is resisted when the bladed rotor is rotated. Such a blade root is commonly known as a "fir tree" root.

Due to the severe stress conditions apt to be encountered, particularly in the case of bladed rotors operating in gas turbine plant, the design of a satisfactory root attachment has been a matter of considerable difficulty over a long period. It has hitherto been considered necessary to use serrations having teeth of a buttress type wherein one face makes a relatively small angle (i.e. 10—15 degrees) with a plane normal to the inclined side of the root, while the other face is inclined at a relatively large angle (i.e. 50—60 degrees) to this side.

In such a mounting it is necessary to use a different design of blade root for every different turbine and this leads to an unnecessarily large number of tools, jigs, etc., and furthermore, the formation of the buttress teeth presents a number of manufacturing difficulties, particularly in the case of the grooves in the rotor. These grooves are usually formed by a broaching operation, and to facilitate machining it is necessary that the angles of the serrations shall be as wide as possible, and that any sharp corners shall be avoided.

The present invention seeks to provide a mounting which will lend itself readily to easier manufacture and standardisation, while at the same time providing a strength at least equal to that of a mounting employing the buttress type of tooth.

For this purpose, the invention provides a mounting for blades of the kind described in which the serrations on the blade root and its seating recess are each symmetrical about a plane normal to the inclined sides of the blade root and of the recess respectively.

It is desirable that the minimum width between the troughs of the serrations at the extreme end of the root remote from the blade tip shall not be less than 0.07 inches, otherwise difficulties will arise in forming the serrations in the rotor groove. The extreme end of the root may in consequence be truncated to form a flat surface, and a corresponding flat surface may be formed at the bottom of the rotor groove, which surface may be used as a guide for the broach when machining the serrations.

The crests of the teeth forming the serrations are preferably truncated and in one preferred embodiment a blade root is provided with seven such teeth.

The profile of the serrations may be similar to that of a normal symmetrical screw thread, and preferably the tooth angle, that is the angle between the opposite faces of a tooth, is approximately 55 degrees as in the standard Whitworth

[*Price* 2/8]

thread. The included root angle, that is the angle of taper between the inclined sides, is approximately 30 to 40 degrees. The pitch of the teeth should be of the order of 0.07 to 0.1 inches.

A blade mounting according to the invention enables the blade root to be standardised so that the same design of blade root may be used for different turbines, different conditions being allowed for by the use of a smaller number of teeth, i.e. two or three or four teeth instead of seven teeth, while each tooth retains the same size and form as above described.

By way of example, one form of blade mounting according to the invention is shown in the drawings accompanying the Provisional Specification in which:—

Figure 1 is an axial section through the blade root;

Figure 2 is an enlarged view of two teeth.

In Figure 1 a blade root 1 has tapered sides 2, 3, which are inclined at an angle of 30 degrees, and each side is provided with seven serrated teeth 4, each of which is symmetrical about a plane such as A—B, which plane is normal to the inclined side 3 of the blade root 1.

In the example shown the tooth angle is 55 degrees, and the minimum width between the troughs 5, 6, of the lowermost serration is .075 inches.

The end of the root surface 7 is substantially flat and normal to the blade axis (as can be seen in the drawing) and the uppermost serration is provided with a uniform run-out 8.

A blade mounting of the kind described fulfils the requirements of maximum use of minimum weight of material, simplicity of manufacture and the insertion of as many blades as possible into a given disc.

It is found that a mounting of this kind gives at least equal stress conditions and in some cases better stress conditions than a mounting with buttress teeth and in some conditions, the blade root according to the invention gives an increased ratio of shear area to tensile area, an increased ratio of width across the neck to width across corresponding teeth, and an increased length of straight mating surfaces of the serrations. The blade root according to the invention also enables the blade platform to be reduced in width while still satisfying the condition of uniform run-out, and by virtue of its symmetrical form is considerably easier to manufacture and control than the buttress type of tooth.

What we claim is:—

1. A mounting for blades of the kind described in which the serrations on the blade root and its seating recess are each symmetrical about a plane normal to the inclined sides of the blade root and of the recess respectively.

2. A mounting according to Claim 1 in which the extreme end of the blade root and the bottom of the seating recess are each formed with a flat surface normal to the blade axis.

3. A mounting according to Claims 1 or 2 in which the crests of the serrations are truncated.

4. A mounting according to any one of the preceding Claims in which the minimum distance between the troughs of the serrations at the end of the root remote from the blade is not less than 0.07 inches.

5. A mounting according to any one of the preceding Claims in which the angle between the inclined faces of each serration is of the order of 55 degrees.

6. A mounting according to any one of the preceding Claims in which the angle between the inclined root faces is of the order of 30 to 40 degrees.

7. A mounting according to any one of the preceding Claims in which the pitch of the serrations is of the order of 0.07 to 0.1 inches.

8. A mounting for blades of the kind described substantially as herein described with reference to and as illustrated in the drawings accompanying the Provisional Specification.

9. A rotor blade for an axial flow compressor, turbine or the like having a root form conforming to the requirements of a mounting as claimed in any one of the preceding Claims.

10. A rotor for an axial flow compressor, turbine or the like having blade root seatings conforming to the requirements of a mounting as claimed in any one of Claims 1 to 8.

J. R. TOD,
Chartered Patent Agent,
Agent for the Applicants.

PROVISIONAL SPECIFICATION

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We, POWER JETS (RESEARCH AND DEVELOPMENT) LIMITED, a British Company, of 25, Green Street, London, W.1, do hereby declare the nature of this invention to be as follows:—

This invention relates to an improved

mounting for blades for axial flow turbines, compressors and the like of the kind which are attached to the rotor disc by the provision on the blade of a radially extending root section adapted to enter a radially and axially extending seating recess in the rotor rim, both root and recess tapering in width to present an approximately triangular form, and the inclined sides of the root section having toothed serrations adapted to engage in complementary serrated grooves in the inclined sides of the rotor recess so that radial displacement of the blade is resisted when the bladed rotor is rotated. Such a blade root is commonly known as a " fir tree " root.

Due to the severe stress conditions apt to be encountered, particularly in the case of bladed rotors operating in gas turbine plant, the design of a satisfactory root attachment has been a matter of considerable difficulty over a long period. It has hitherto been considered necessary to use serrations having teeth of a buttress type wherein one face makes a relatively small angle (i.e. 10—15 degrees) with a plane normal to the inclined side of the root, while the other face is inclined at a relatively large angle (i.e. 50—60 degrees) to this side.

In such a mounting it is necessary to use a different design of blade root for every different turbine and this leads to an unnecessarily large number of tools, jigs, etc., and furthermore, the formation of the buttress teeth presents a number of manufacturing difficulties.

The present invention therefore seeks to provide a mounting which will lend itself readily to easier manufacture and standardisation while at the same time providing a strength at least equal to the buttress type of tooth.

For this purpose the invention provides a mounting for blades of the kind described in which the teeth of the blade root serrations are each symmetrical about a plane normal to the inclined side of the blade root in which the serration is formed.

Preferably the tooth angle is approximately 55 degrees and the included root angle, i.e. the angle of taper between the inclined sides is approximately 30 degrees. It is also preferred that the minimum width between the necks of the serrations at the extreme end of the root remote from the blade tip shall be not less than 0.07 inches and that the pitch of the tooth shall be of the order of 0.07 to 0.1 inches.

The crests of the teeth are preferably truncated and in one preferred embodiment a blade root is provided with six such serrated teeth.

A blade mounting according to the invention enables the blade root to be standardised so that the same design of blade root may be used for different turbines, different conditions being allowed for by the use of a smaller number of teeth, i.e. two or three or four teeth instead of six teeth while each tooth retains the general form above described.

By way of example one form of blade mounting according to the invention is shown in the accompanying drawings in which:—

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In the example shown the tooth angle is 55 degrees, and the minimum width between the troughs 5, 6, of the lowermost serration is .075 inches.

The end of the root surface 7 is substantially flat and the uppermost serration is provided with a uniform run-out 8.

A blade mounting of the kind described fulfils the requirements of maximum use of minimum weight of material, simplicity of manufacture and the insertion of as many blades as possible into a given disc.

It is found that a mounting of this kind gives at least equal stress conditions and in some cases better stress conditions than a mounting with buttress teeth and in some conditions, the blade root according to the invention gives an increased ratio of shear area to tensile area, an increased ratio of width across the neck to width across corresponding teeth, and an increased length of straight mating surfaces of the serrations. The blade root according to the invention also enables the blade platform to be reduced in width and by virtue of its symmetrical form is considerably easier to manufacture and control than the buttress type of tooth.

Dated this 24th day of August, 1949.

J. R. TOD,
Chartered Patent Agent,
Agent for the Applicants.

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